INTERNATIONAL STANDARD

ISO 4997

Third edition
1999-03-01

Cold-reduced steel sheet of structural quality

Tôles en acier de construction laminées à froid

Reference number
ISO 4997:1999(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4997 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products.*

This third edition cancels and replaces the second edition (ISO 4997:1991) which has been technically revised.

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Cold-reduced steel sheet of structural quality

1 Scope

1.1 This International Standard applies to cold-reduced steel sheet of structural quality in grades CR220, CR250, CR320 and CH550 in the classes given in table 1, usually without the use of microalloying elements. The product is intended for structural purposes where particular mechanical properties are required. It is generally used in the delivered condition for fabricating purposes, such as bending, forming or welding.

1.2 This product is commonly produced in thicknesses from 0,36 mm up to 3 mm and in widths of 600 mm and over, in coils and cut lengths.

1.3 Cold reduced sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

1.4 This International Standard does not cover steels designated as commercial quality or drawing qualities (covered in ISO 3574), cold-reduced carbon steel sheet to hardness requirements (covered in ISO 5954), cold reduced steel sheet of higher strength with improved formability (covered in ISO 13887), or cold-reduced steel sheet of high tensile strength and low yield point with improved formability (covered in ISO 14590).

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
microalloying elements
elements, such as niobium, vanadium, titanium, etc., added singly or in combination to obtain higher strength levels combined with better formability, weldability and toughness as compared to non-alloyed steels produced to equivalent strength levels

3.2
cold-reduced steel sheet (grades CR220, CR250 and CR320)
product obtained from hot-rolled descaled steel sheet by cold reducing to the required thickness (full hard) followed by annealing to recrystallize the grain structure

NOTE 1 This annealed product is normally supplied skin passed (see 3.3) but may be supplied annealed last (i.e. without a skin pass), if specified by the purchaser on his order.

NOTE 2 CH550 is a product which has not been annealed after reduction to the specified thickness.

3.3
skin pass (except grade CH550)
light cold rolling of the product the purpose of which is one or more of the following:

a) to minimize the appearance of coilbreaks, stretcher strains and fluting;

b) to control the shape;

c) to obtain the required surface finish

NOTE Some increase in hardness and some loss in ductility will result from skin passing.

4 Conditions of manufacture

4.1 Steelmaking

Unless otherwise agreed upon, the processes used in making the steel and in manufacturing cold-reduced steel sheet are left to the discretion of the manufacturer. On request, the purchaser shall be informed of the steelmaking process being used.

4.2 Chemical composition

The chemical composition (heat analysis) shall conform to the requirements given in tables 1 and 2.

Table 1 — Chemical composition (heat analysis)

Content levels in percent

Grade	Class	Method of deoxidation	C max.	Mn max.	P max.	S max.
CR220	B	E or NE	0,15	Not applicable	0,035	0,035
	D	CS	0,15	Not applicable	0,035	0,035
CR250	B	E or NE	0,20	Not applicable	0,035	0,035
	D	CS	0,20	Not applicable	0,035	0,035
CR320	B	E or NE	0,20	1,50	0,035	0,035
	D	CS	0,20	1,50	0,035	0,035
CH550	Not applicable	Not applicable	0,20	1,50	0,035	0,035

NOTE 1 E = Rimming
NE = Non-rimming
CS = Aluminium killed

NOTE 2 The nitrogen content is controlled; normally it should not exceed 0,009 % for E or NE steel or 0,015 % for CS steel.

NOTE 3 Class B steels are intended for use in welded structures or structural parts, subjected to normal loading conditions.

NOTE 4 Class D steels are to be used for structures or structural parts where, owing to loading conditions and the general design of the structure, a high resistance to brittle fracture is necessary.

Table 2 — Limits on additional chemical elements

Content levels in percent

Elements	Heat analysis max.	Product analysis max.
Cu [a]	0,20	0,23
Ni [a]	0,20	0,23
Cr [a b]	0,15	0,19
Mo [a b]	0,06	0,07
Nb [c]	0,008	0,018
V [c]	0,008	0,018
Ti [c]	0,008	0,018

[a] The sum of copper, nickel, chromium, and molybdenum shall not exceed 0,50 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.

[b] The sum of chromium and molybdenum shall not exceed 0,16 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.

[c] Analysis greater than 0,008 % may be supplied after agreement between producer and consumer.

4.3 Chemical analysis

4.3.1 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements given in table 1 and table 2. When requested at the time of ordering, this analysis shall be reported to the purchaser or to his representative.

Each of the elements listed in table 2 shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium or molybdenum present is less than 0,02 %, the analysis may be reported as "< 0,02 %".

4.3.2 Product analysis

A product analysis may be made by the purchaser in order to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped) are not technologically suited to product analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering.

4.4 Weldability

The product is normally suitable for welding if appropriate welding conditions are selected. As the carbon content increases above 0,15 %, spot welding becomes increasingly difficult. Because the heat of welding might have a significant effect on lowering the strength of grade CH550, this grade is not recommended for welding.

4.5 Application

It is desirable that cold-reduced steel sheet be identified for fabrication by the name of the part or by the intended application, which shall be compatible with the grade and class specified. Proper identification of the part may include visual examination, prints or description, or a combination of these.

4.6 Mechanical properties

At the time that the steel is made available for shipment, the mechanical properties shall be as stated in table 3, when they are determined on test pieces obtained in accordance with the requirements of clause 7.

NOTE Prolonged storage of the sheet may cause a change in the mechanical properties (increase in hardness and a decrease in elongation) leading to an adverse effect on formability.

Table 3 — Mechanical properties

Grade	R_e[a] N/mm^2	R_m min. N/mm^2	A[b] min. L_o = 50 mm	A[b] min. L_o = 80 mm
CR220	220	300	22	20
CR250	250	330	20	18
CR320	320	400	16	14
CH550	550	[c]	Not applicable	Not applicable

R_e = yield stress — can be either R_{eL} or R_{eH} but not both

R_{eL} = lower yield stress

R_{eH} = higher yield stress

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

1 N/mm^2 = 1 MPa

[a] The yield stress values can be measured by 0,5 % elongation proof stress (proof stress under load) or by 0,2 % offset when a definite yield phenomenon is not present.

[b] Use either L_o = 50 mm or L_o = 80 mm.

[c] For grade CH550 the yield point approaches the tensile strength and since there is no hesitation of the pointer or drop of the beam, the lower yield stress (R_{eL}) shall be taken as the stress at 0,5 % total elongation under load in accordance with ISO 6892.

4.7 Surface condition

The condition of the surface of cold-reduced steel sheet is not required to be the same for unexposed parts as it is for exposed parts.

Surface condition of sheet for unexposed parts may contain pores, some slight pitting, small markings, light scratches and a light discoloration. The surface of sheet for exposed parts shall be reasonably free of these conditions. Unless otherwise agreed, only one side shall be inspected.

4.8 Surface finish

Cold-reduced steel sheet is normally produced in matte finish, dull in appearance, which is suitable for ordinary decorative painting but is not recommended for electroplating.

When cold-reduced steel sheet is deformed during fabrication, localized areas may roughen to some degree and such affected portions of the part may require hand finishing to prepare the surface for the intended application.

4.9 Oiling

As a deterrent to rusting, a coating of oil is usually applied to the product. The oil is not intended as a drawing or forming lubricant and shall be easily removable using degreasing chemicals. The product may be ordered not oiled, if required, in which case, the supplier has limited responsibility if oxidation occurs.

5 Dimensional tolerances

5.1 Dimensional tolerances applicable to cold-reduced steel sheet of structural quality shall be as given in table 4 to table 11.

5.2 Restricted thickness tolerances are given in table 5.

6 Tensile test – sampling

One representative sample for the tensile test required in table 3 shall be taken from each lot of sheet for shipment. A lot consists of 50 t or less of sheet of the same grade and class rolled to the same thickness and condition.

7 Tensile test

The tensile test shall be carried out in accordance with the requirements of ISO 6892. Transverse test pieces shall be taken midway between the centre and edge of the sheet as rolled.

8 Retests

8.1 Machining and flaws

If any test piece shows defective machining or develops flaws, it shall be discarded and another test piece substituted.

8.2 Elongation

If the percentage elongation of any test piece is less than that specified in table 3 and if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded and a retest shall be carried out.

8.3 Additional tests

If a test does not give the specified results, two more tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this International Standard; otherwise, the lot may be rejected.

9 Resubmission

9.1 The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he has subjected them to a suitable treatment (selection, heat treatment) which, on request, will be indicated to the purchaser.

In this case, the tests shall be carried out as if they applied to a new batch.

9.2 The manufacturer has the right to present the rejected products for fresh examination for compliance with the requirements for another grade or class.

10 Workmanship

The surface condition shall be that normally obtained in a cold-reduced product.

The steel sheet in cut lengths shall be free from amounts of laminations, surface flaws, and other imperfections that are detrimental to the final product or to subsequent appropriate processing.

Processing for shipment in coils does not afford the manufacturer the opportunity of readily observing or of removing imperfect portions as can be carried out on the cut length product.

11 Inspection and acceptance

11.1 While not usually required for products covered by this International Standard, when the purchaser specifies that inspection and tests for acceptance be observed prior to shipment from the manufacturer's works, the manufacturer shall afford the purchaser's inspector all reasonable facilities to determine that the steel is being furnished in accordance with this International Standard.

11.2 Steel that is reported to be defective after arrival at the user's works shall be set aside, properly and correctly identified and adequately protected. The supplier shall be notified in order that he be able properly investigate.

12 Coil size

When cold-reduced steel sheet is ordered in coils, a minimum inside diameter (I.D.) or range of acceptable inside diameters shall be specified. In addition, the maximum outside diameter (O.D.) and the maximum acceptable coil mass shall be specified

13 Marking

Unless otherwise stated, the following minimum requirements for identifying the steel shall be legibly stencilled on the top of each lift or shown on a tag attached to each coil or shipping unit.

a) the manufacturer's name or identifying brand;

b) the number of this International Standard, i.e. ISO 4997;

c) the grade and class designations;

d) the order number;

e) the product dimensions;

f) the lot number;

g) the mass.

14 Information to be supplied by the purchaser

To specify adequately the requirements of this International Standard, enquiries and orders shall include the following information:

a) the number of this International Standard, i.e. ISO 4997;

b) the name, quality, grade and class of the material (for example, cold-reduced steel sheet, structural quality, grade CR220 class B);

c) whether oiled or not oiled (see 4.9);

d) the dimensions of the product and the quantity required;

e) the application (name of part) if possible (see 4.5);

f) the report of the mechanical properties and/or the heat analysis (see 4.6 and 4.3.1) if required;

g) limitations on masses and dimensions of individual coils and bundles, if applicable (see clause 12);

h) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see 11.1);

i) restricted thickness tolerances, if required (see 5.2);

j) R_{eH} or R_{eL} specified where required (see table 3).

EXAMPLE

International Standard 4997, cold-reduced steel sheet, structural quality, grade CR220 class B, normal thickness tolerances, 1 mm × 700 mm × 1 800 mm, 40 000 kg, for part No. 3456, seat frame-unexposed, furnish report of mechanical properties, maximum lift 4 000 kg.

Table 4 — Normal thickness tolerances for coils and cut lengths

Values in millimetres

Specified width	Thickness tolerances for specified thicknesses								
	⩽ 0,4	> 0,4 ⩽ 0,6	> 0,6 ⩽ 0,8	> 0,8 ⩽ 1,0	> 1,0 ⩽ 1,2	> 1,2 ⩽ 1,6	> 1,6 ⩽ 2,0	> 2,0 ⩽ 2,5	> 2,5 ⩽ 3,0
600 ⩽ 1 200	±0,04	±0,05	±0,07	±0,08	±0,09	±0,11	±0,13	±0,15	±0,18
> 1 200 ⩽ 1 500	±0,05	±0,06	±0,08	±0,09	±0,10	±0,12	±0,14	±0,16	±0,19
> 1 500 ⩽ 1 800	—	±0,08	±0,09	±0,10	±0,12	±0,14	±0,16	±0,18	±0,21

NOTE 1 The thickness tolerances for sheet in coil form are the same as for sheet supplied in cut lengths but in cases where welds are present the tolerances shall be double those given over a length of 15 m in the vicinity of the weld.

NOTE 2 Thickness is measured at any point on the sheet not less than 25 mm from a side edge.

NOTE 3 Tolerances for grade CH550 shall be agreed upon between the purchaser and the manufacturer.

Table 5 — Restricted thickness tolerances for coils and cut lengths

Values in millimetres

Specified width	Thickness tolerances for specified thicknesses								
	⩽ 0,4	> 0,4 ⩽ 0,6	> 0,6 ⩽ 0,8	> 0,8 ⩽ 1,0	> 1,0 ⩽ 1,2	> 1,2 ⩽ 1,6	> 1,6 ⩽ 2,0	> 2,0 ⩽ 2,5	> 2,5 ⩽ 3,0
600 ⩽ 1 200	± 0,025	± 0,035	± 0,04	± 0,045	± 0,055	± 0,07	± 0,08	± 0,10	± 0,11
> 1 200 ⩽ 1 500	± 0,035	± 0,045	± 0,05	± 0,06	± 0,07	± 0,08	± 0,09	± 0,11	± 0,12
> 1 500 ⩽ 1 800	—	± 0,05	± 0,05	± 0,06	± 0,07	± 0,08	± 0,09	± 0,11	± 0,12

NOTE 1 The thickness tolerances for sheet in coil form are the same as for sheet supplied in cut lengths but in cases where welds are present the tolerances shall be double those given over a length of 15 m in the vicinity of the weld.

NOTE 2 Thickness is measured at any point on the sheet not less than 25 mm from a side edge.

NOTE 3 Tolerances for grade CH550 shall be agreed upon between the purchaser and the manufacturer.

Table 6 — Width tolerances for coils and cut lengths, not resquared

Values in millimetres

Specified widths	Tolerance
⩽ 1 200	+ 5 0
> 1 200 ⩽1 500	+ 7 0
> 1 500	+ 9 0

NOTE For resquared material more restrictive tolerances are subject to negotiation.

Table 7 — Length tolerances for cut lengths, not resquared

Values in millimetres

Specified lengths	Tolerance
⩽ 3 000	+ 20 0
> 3 000 ⩽6 000	+ 30 0
> 6 000	+ 0,5 % × length 0

NOTE For resquared material more restrictive tolerances are subject to negotiation.

Table 8 — Camber tolerances for coils and cut lengths, not resquared

Form	Camber tolerance
Coils	20 mm in any 5 000 mm length
Cut lengths	0,4 % × length

NOTE 1 For resquared material more restrictive tolerances are subject to negotiation.

NOTE 2 Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight edge.

Table 9 — Out-of-square tolerance for cut lengths, not resquared

Dimensions	Out-of-square tolerance
All thicknesses and all sizes	1 % × width

NOTE Out-of-square is the greatest deviation of an end edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in figure 2. It can also be measured as one-half the difference between the diagonals of the cut length sheet.

Table 10 — Out-of square tolerances for resquared material

Values in millimetres

Specified lengths	Specified widths	Out-of-square tolerance
⩽ 3 000	⩽ 1 200	$^{+2}_{0}$
	> 1 200	$^{+3}_{0}$
> 3 000	All widths	$^{+3}_{0}$

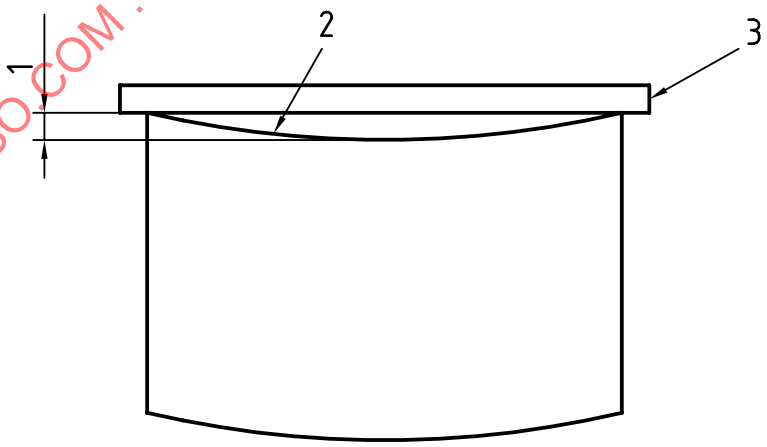
NOTE 1 Out-of-square is the greatest deviation of an end edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in figure 2. It can also be measured as one-half the difference between the diagonals of the cut length sheet

NOTE 2 When measuring material to resquared tolerances, consideration may have to be given to extreme variations in temperature

Table 11 — Standard flatness tolerances for cut lengths

Values in millimetres

Specified thickness	Specified width	Flatness tolerance[a]
⩽ 0,7	⩽ 1 200	23
	> 1 200 ⩽ 1 500	27
	> 1 500	33
> 0,7 ⩽ 1,2	⩽ 1 200	18
	> 1 200 ⩽ 1500	23
	> 1 500	29
> 1,2	⩽ 1 200	15
	> 1 200 ⩽ 1 500	19
	> 1500	26
NOTE 1 This table also applies to sheet cut to length from coils by the customer when agreed upon flattening procedures are performed. NOTE 2 This table does not apply to full hard sheet (CH550).		
[a] Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness (see figure 3).		



Key

1 Edge camber
2 Side edge (concave side)
3 Straightedge

NOTE Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight edge.

Figure 1 — Measurement of camber